The Effect of the recent Eruption on the Plants of Ngauruhoe

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Abstract.

The effect on the vegetation of hot lava and ash associated with the recent eruption of Ngauruhoe, and a description of the plant community in the vicinity of the new deposits. A rare opportunity is presented for subsequent recording of plant colonization of virgin ground.

1. *The Eruption:* Ngauruhoe, 7,500 feet high (2286 m.), is the central peak in a short chain which has shown intermittent volcanic activity for many years. The recent eruption began on 9th February, 1949, with the discharge of rocks from the crater. Lava emerged on the following day, and streamed down the north-west slope of the cone into the Mangatepopo Valley. The eruption of ash clouds followed the lava phase, and continued until all activity ceased about the end of February. Two bare areas resulted from the eruption. The larger area is the lava flow, about 6,000 feet long (1829 m.) and 180 to 420 feet wide (55 to 128 m.). It descends from 7,500 feet (2286 m.) to 4,700 feet (1432 m.). The second area is the debris fan at about 4,550 feet (1386 m) above sea level. It is situated below the new lava flow, on the old lavas in the Mangatepopo Valley, and is at least 450 feet (137 m.) long by 360 feet (110 m.) wide, but the boundaries of it are not clearly defined.

Cockayne (1908) has outlined generally the sequence of events in the development of a plant covering on the Volcanic Plateau, and the recent eruption has presented an opportunity to study the process on a new lava flow and a debris fan. It is known that volcanic deposits are very sterile and that the development of vegetation on them is relatively slow, but the new deposits are small in area and readily accessible to plant migrants.

It may be many years before there is anything to record, but there is little information on the subject and the opportunity to observe the colonization of an area of virgin ground, under natural conditions, is too rare to be missed. Aston (1916) and Turner (1928) have described the new vegetation of the mud and ash deposits of Tarawera, and Oliver (1942) has recorded the colonization of the Napier harbour bed raised by the 1931 earthquake.

The aim of this paper is to describe the present plant community in the vicinity of the new deposits, and to record the effect of the hot lava and ash on the vegetation.

2. *The Habitat:* Allan (1926) has described the variety of habitats or growing places provided by rocks, and pointed out the need for detailed records with instruments. At this stage of the study, however,

only a general account of the climatic factors is possible. Cockayne (1908) had little meteorological data, but remarked that the volcanic plateau lies across the path of cyclonic depressions and has a much more abundant rainfall on the tree-clad south and west than on its eastern side. Weather records have been kept in recent years at the Chateau Tongariro, 3,670 feet (1183 m.) above sea level, and some six miles (9.6 km.) south of the new lava flow and debris fan.

The mean annual rainfall is 106 inches (269 cm.). The number of days with rain each year averages 186, and the mean monthly rainfall ranges from 6.91 inches (17.55 cm.) in February to 10.77 inches (27.35 cm.) in October. The range in mean monthly temperatures is from 35.5° F. (1.9° C.) in July to 53.1° F. (11.7° C.) in February. The absolute minimum for the 12 months ended July, 1949 was 21° F. (— 6° C.) and the absolute maximum was 79° F. (26° C.). The director of Meteorological Services, Air Department, Wellington, has supplied the following table, from which most of the figures quoted above are taken.

CHATEAU TONGARIRO.

Lat. 39°12'S; Long. 175°32'E. Alt. 3,670ft.

	1 Jan.	2 Feb.	3 Mar.	4 Apl.	5 May	6 June	7 July	8 Aug.	9 Sep.	10 Oct.	11 Nov.	12 Dec.	Yr. or Mean
Rainfall (in.):	8.41	6.91	6.94	8.92	7.96	10.38	9.08	8.40	10.55	10.77	9.02	8.89	106.23
Raindays:	16	14	13	15	16	15	15	17	16	17	15	17	186
Approx. Mean Tem. (°F.) = ½ (Max. + Min.)	52.4	53.1	50.6	46.2	40.6	36.7	35.5	37.1	38.8	42.5	46.4	49.2	44.1

Temperatures change rapidly with clouding, and night frosts are common at all seasons. Small patches of snow remain all the year on the upper slopes of Ngauruhoe and the cone is covered in the winter and spring. The main falls are in June, July and August, but falls have been recorded in all seasons.

The Director of Meteorological Services has advised that wind records at the Chateau are based on non-instrumental observations and that he is unable to supply detailed wind statistics. A wind rose for the years 1939 to 1944 has been prepared from the published observations, taken at 9 a.m. each day, and it shows that approximately 50% of the winds blow from between the north-west and south-west.

The soil factor, and the important effect it has on the vegetation, has been described by Cockayne (1908, p. 23). The north-west slope of Ngauruhoe, about the new lava flow and debris fan, is dissected by shallow dry ravines. The ridges between the ravines are old lava flows, and the soil is restricted to crevices and hollows. In the summer months, the limited soil or humus covering, and the rapid drainage on the steep slopes, result in drought conditions, although the area is subject to a heavy and regular rainfall.

A hot avalanche of the morning of February 9, photographed from Mangatepopo Hut.
Photo. by courtesy of
Mr. R. H. Bates, Wanganui.

The lava flow at mid-day on February 11.

Photo: M. H. Battey.

3. *The Vegetation:* Cockayne (1908) listed 38 ferns and 222 seed-plants in the Tongariro National Park. At least 45 are to be found in the Mangatepopo Valley, forming a dense cover in the Mangatepopo Gorge and in sheltered hollows among old, weathered lava flows. On the north-west slope of Ngauruhoe above the valley floor the plants become fewer, and at 6,000 feet (1829 m.) the slopes are barren. At 4,700 feet (1432 m.), on the slopes about the new lava flow and debris fan, six one-metre permanent quadrats were painted on the rocks, a 30-metre bisect was dug, and 35 one-metre quadrats were selected at random an listed. Only 10 species of plants were found, but a rapid examination of the slopes indicated that this is the total number present in the immediate vicinity of the flow and debris fan. All of the species are members of the richer flora of the Mangatepopo Valley. The species list is given below. The frequency, on the usual 1-5 notation, is shown on the left-hand side of the list. The area of each quadrat occupied by plants has been estimated and the total cover of vegetation works out at 9% of the area studied. The cover of each species has been worked out and is expressed as a percentage of the total cover. The percentages are shown on the right-hand side of the species list.

CHATEAU TONGARIRO.

Frequency.	Name of Species.	Percentage of total cover.
4	*Danthonia setifolia* (Hook. f.) Ckn.	18%
3	*Dracophyllum recurvum* Hook. f.	47%
1	*Anisotome aromatica* Hook. f.	1%
1	*Gaultheria colensoi* Hook. f.	4%
1	*Helichrysum bellidioides* (Forst. f.) Willd.	1%
1	*Raoulia australis* Hook. f. ex Raoul	1%
2	*Stereocaulon denudatum* Flk. (lichen)	25%
2	*Rhacomitrium crispulum* (H. f. & W.) H. f. & W. *R. lanuginosum* (Hedw.) Brid. var. *pruinosum* H. f. & W. *Campylopus clavatus* (R. Br.) H. f. & W.	(mosses) 3%

Dried specimens of each species have been placed in the Cheeseman Herbarium at the Auckland Museum.

The area studied may not be large enough to give a true picture of the frequency and cover of each species, but the time available for the work was limited.

Although *Danthonia* was found in more quadrats than *Dracophyllum,* the latter covers a larger area and its red foliage gives the community a characteristic appearance. The small area occupied by lichens is surprising, but possibly the occasional deposits of ash are responsible for their scarcity.

The total area figure shows the open character of the community. There are plenty of suitable places for colonization which are not occupied, and the contrast between the community and the closed vegetation of the lower Mangatepopo Valley is most marked. Geologically, the

terrain becomes younger as the Mangatepopo Valley is ascended, and Cockayne (1908, p. 25) states that the open community is merely an early phase in the development of vegetation. A record of changes in the area figures of the permanent quadrats may throw light on the development phases.

The habit of *Dracophyllum recurvum* and *Danthonia setifolia* have been described by Cockayne (1908) and the chief adaptation features are stated to be great length of root and closeness to the ground. All the seed plants are perennials with marked xeromorphic features. The bisect showed that *Dracophyllum* develops roots on buried branches, an adaptation which may enable the plant to survive burial in ash. The bisect also showed that the main roots of the seed plants are in the top 8 inches (20 cm.) of soil. Although the community is an open one, competition between the roots of *Danthonia* and the other seed plants was found in six pockets of vegetation traversed by the bisect.

4. *The Effect of the Eruption on the Land Surface and the Vegetation:* The location and area of the lava flow and debris fan have been described, and Battey is preparing a map for publication. The lava flow consists of blocky andesite, the surface of which is still somewhat unstable. The debris fan is composed of large blocks of rock embedded in sand. The rock came from avalanches at the beginning of the eruption and from lava masses which rolled down from the flow. The sand is probably derived from the early avalanches, and the ash showers which concluded the eruption. Both the lava flow and the debris fan had warm areas in May.

The rock avalanches, and the lava blocks which broke away from the flow, cut a smooth-sided ravine down the north-west slope of the cone and the lava flow advanced down this channel. The vegetation in the path of the flow was destroyed, but it is possible that buried parts of plants have survived in the debris fan. The whole of the north-west slope of the cone was disturbed by falling debris during the eruption, and subsequent erosion has exposed the roots of plants in many places.

The hot ash showers affected the species as follows:

Danthonia—leaf tips charred but the tuft or clump had not disintegrated.

Dracophyllum—apparently unaffected.

Anisotome—leaves shed and new leaves developing.

Gaultheria—leaves charred and shed. Plants appeared dead.

Helichrysum—dried or charred to soil surface but new shoots developing.

Raoulia—dried and apparently dead.

Lichen—charred.

Mosses—charred.

This summary was made on the 18th May. The plants are strongly xeromorphic and, although a number appeared to be dead in May, it is probably that most of them have survived and will produce new shoots when the snow melts in the coming summer.

The hot rocks which reached the floor of the Mangatepopo Valley started a number of fires in the vegetation, but the areas burnt were not large.

The quantity of dust and sand stirred up by the falling stones, produced by the movement of the lava, and erupted during the ash phase, was considerable. A surface layer, varying in depth from several inches to several feet, covered the lower north-west slope of the cone on the 11th February, before the main ash clouds were produced. Much of it had blown or washed into crevices when the mountain was visited last May, and no doubt pockets of it formed in the new lava flow. The slow production of a soil by weathering, and the decay of lichens and mosses, has been described as the first phase in the colonization of bare rock (Cockayne, 1908, p. 26, and 1928, p. 107—note on Rangitoto), but there is some evidence that a soil is present in the crevices of the new lava flow and it is possible that the lichen-moss stage will not be necessary before seed plants migrate to it.

In conclusion, I wish to thank the Director of Meteorological Services, Air Department, Wellington, for supplying statistics of rainfall and temperature, and for granting permission to publish same; Mr. G. O. K. Sainsbury, of Wairoa, for the identification of three mosses; Professor V. J. Chapman, of Auckland University College, for advice regarding this paper; and Mr. M. H. Battey and Miss M. Hurrey, of the Museum staff, for assistance in the field.

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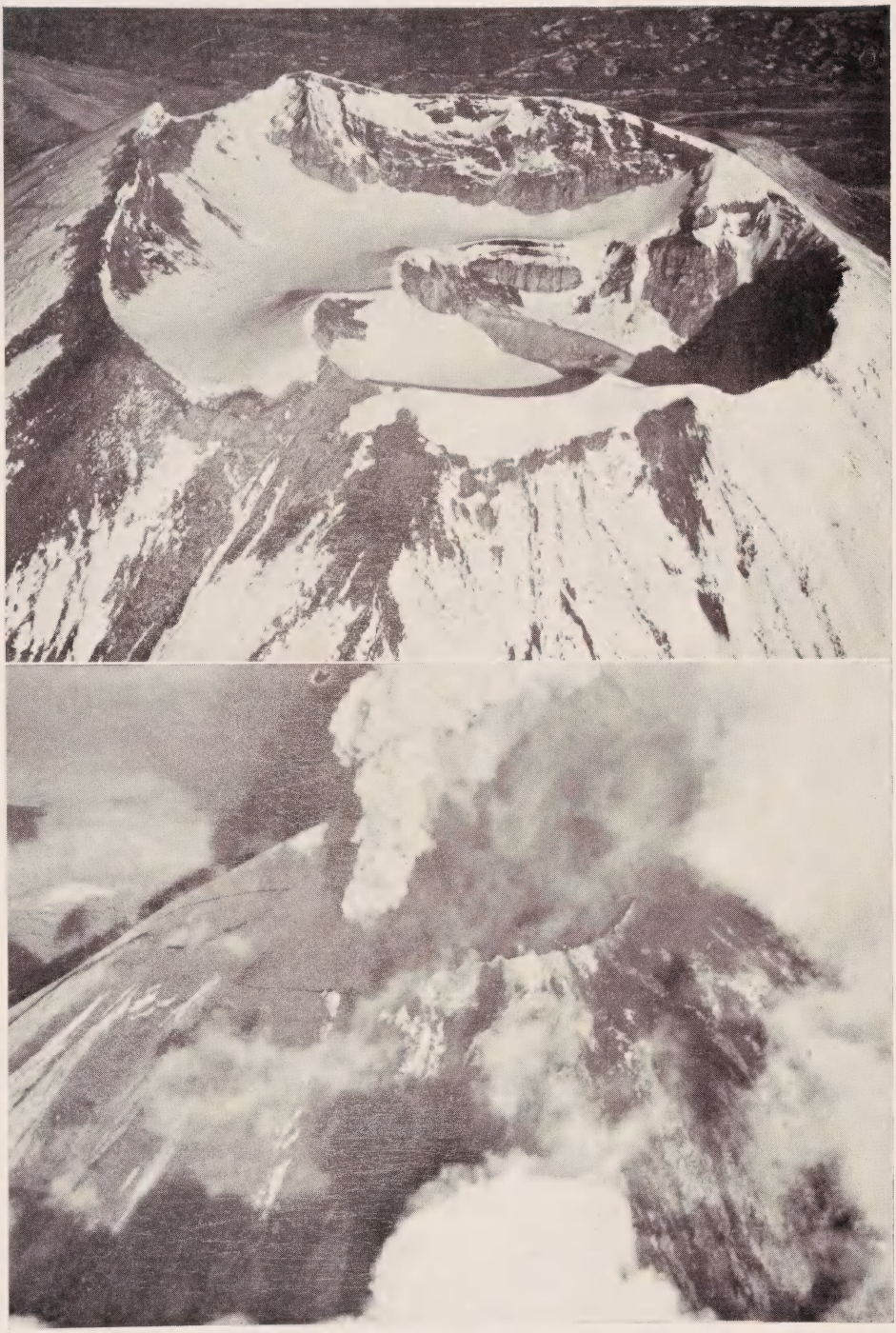

Fig. 1. Ngauruhoe crater from the north in 1934, showing the north-north-west sub-crater (in front) and the west sub-crater in which is a small nested cone.

Photo: Whites Aviation Ltd.

Fig. 2. The crater from the west in the late afternoon of February 9, showing the gently-domed tholoid.

Photo. by courtesy of Mr. S. J. Blackmore, Air Services Ltd., Rotorua.